What is a Beverage Worth? Arbitrage Pricing and the Value of New Products: An Attribute-Space Approach

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In 2007 nearly 10,000 new food and drink products have been introduced to U.S. food retailing (GNPD). This number more than doubles when new packaging, line extensions, and product reformulations are taken into account (GNPD). However, very little research has been conducted that examines 1) the benefits of new product introductions to producers, and 2) how those benefits are related to food manufacturers' decisions to differentiate or imitate in new product offerings. Thus, the objective of this study is to develop a model of new product valuation that will be used to evaluate the decision of whether to differentiate or imitate in new product introductions, and how firm profitability and market valuation are affected by this choice.

The first motivation for such research is provided by food industry facts and projections regarding the development, introduction, and potential success of new products. Considering that over 10,000 new products are introduced each year lends credence to the question of benefits to the various market participants (FMI, GNPD). Making this figure even more remarkable is a realization of the increased level of product assortment faced by U.S. food shoppers. For example, from 1992 to 2002 the average number of items carried by U.S. supermarkets grew from 26,000 to 40,000 (Jekanowski and Binkley 2000; Harris, 2002). However, the rate of new product introductions has remained relatively stable (figure 1).[1]

A probable explanation for these trends is the constant evolution of American consumers. An aging population, better education on the links between diet and health, immigration of ethnic populations, a greater need for convenience, and changes in

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[1] The number of new product introductions declined for five straight years from 1995-2000 (Harris, 2002) but then increased from just under 12,000 in 2001 to over 16,000 in 2004 (GNPD).

income distribution all contribute to the food industry's "mad dash" to develop "the next big thing" (Harris 2002; Variyam 2002; Blisard et al. 2002; Jekanowski and Binkley 2000).

[Figure 1 in here]

Another important consideration is the accounting cost associated with new product introduction. Firms spend millions of dollars on research and development and marketing but often see no positive return to their accounting profits. For example, in 1989 Nabisco spent $20 million on advertising in an attempt to get consumers to purchase their new Breakfast Bears cereal. However, due to the cereal's sogginess in milk, Breakfast Bears failed, costing Nabisco at least $11 million of their original investment (Wood 1995). Furthermore, all of these industry realities have emerged in an environment where it is readily accepted that 70-80% of all new product introductions will ultimately fail (Hamson 2004, Harris 2002). Such a high failure rate exacerbates these costs by providing incentives for retailers to seek investment assurances in the form of slotting and promotion allowances (Richards and Patterson 2004). In addition, some have suggested that firms raise the prices of their established products in an effort to balance the losses associated with a new product failure, thus passing a portion of their burden on to consumers (Stewart and Martinez 2002). In short, when it comes to new product introductions, the existing levels of supermarket assortment, the probability of failure, and the costs associated with such failure are all quite high. Yet the pace of new product introductions has not receded.

The economic incentives that underlie new product development are only partially understood. Differentiation has a number of advantages. First, products that are seen as unique allow a firm to develop a distinct brand image, one that creates a more inelastic demand for an entire product line. Inelastic demand, in turn, allows the firm to charge higher margins on all products offered. Second, differentiation means that advertising and other promotional activities will be more profitable because the margin on each incremental product sold is correspondingly higher. Third, differentiated products are less likely to suffer from cannibalization from other products in the own-firm's product line, or competitive erosion from other firm's products. Fourth, because consumers tend to be variety-seeking (Draganska and Jain, 2005), products that are fundamentally different from others will appeal to consumers' preference for choice. On the other hand, imitating existing products entails a number of benefits as well. First, the business-stealing effect of locating new products close to successful incumbent products in attribute space is the most obvious reason for imitation. Second, to the extent that manufacturers are able to internalize pricing externalities within their own product line (Nevo, 2001), locating new products near to others will maximize this "portfolio" pricing effect. Third, to the extent that many imitative product introductions are brand extensions, the cost of developing and marketing a new product that is a simple derivative of another offered by the firm is considerably lower than developing and entirely new good. Fourth, if existing brands enjoy a loyal following of consumers who are relatively price-insensitive, then locating a product near to this dominant brand will allow retailers to price-discriminate by offering the new, alternative-brand product at a lower price in order to attract a more price-

sensitive cohort. This is the strategy behind many retailers' private-label strategies (Richards and Hamilton, 2006).

Although the basic economics of product introduction outlined above remain true whether the firm maximizes single-period profit or long-term firm value, we hypothesize that other considerations will become important. Whereas Wang and Stiegert (2006) argue that considering financial risk in a strategic delegation context leads to softer price competition as firms seek to minimize financial market risk, we hypothesize that the opposite is more likely to be true. This result has dramatic implications for optimal product introduction strategies. Namely, Wang and Stiegert argue that firms that collusion will have lower cash-flow variance and, hence higher equity values. However, collusion implies higher covariance with the market, higher systematic risk, higher betas and lower equity values, ceteris paribus. In contrast to Wang and Stiegert, therefore, innovation will be rewarded by equity markets and not penalized. Further, existing studies that integrate product-market strategies and and financial-market objectives develop static firm valuation models. However, this is fundamentally inconsistent with value maximization and simplifies away many of the most interesting results. In this research, we will investigate the implications of product-market strategies on fully dynamic firm valuation models – models that are more consistent with the CAPM as originally conceived.

An additional consideration associated with new product proliferation is the relatively fixed nature of shelf space and the challenges retailers face in deciding whether or not to stock a new product. Excess demand for shelf space and the risks of product failure have contributed to the well researched topic of slotting allowances and

promotional payments (Hauser, Simester, & Wenerfelt 1997; Bloom, Gundlach, & Cannon 2000; Richards and Patterson 2004; and Israilevich 2004). Analysis of firm market value associated with new product introductions could be useful to retailers as a way to assist in the estimation of slotting fees. Another interesting consideration regards the fact that nearly 16% of all food product introductions in the last six years have been private label or store brand products (GNPD). Thus, estimation of market value returns to introduction could provide a useful comparison for retailers in terms of what they might expect to gain by using shelf space for their own product versus what they could reasonably charge another manufacturer for use of the space.

To address the problems outlined, we conduct an empirical application involving numerous new product introductions in the U.S. carbonated soft drink (CSD) industry. Our category selection is based on the need to represent three important food industry features. First is the need for a category which represents the high level of new product introductions observed throughout the entire industry. Second, given that the most active categories in terms of new product introductions usually possess a high level of existing differentiation, a product category possessing a large assortment of products is necessary. Third, for maximization of a firm's market value to be a feasible objective in new product introductions we needed to select a category for which new product introductions are likely to be highly publicized, thus increasing the likelihood that financial analysts and investors actually use such information to promote or discourage stock trading. The CSD category fulfills all of these requirements.

Research Objectives

The objective of this article is to determine the value of alternative product development strategies, namely whether food product manufacturers should differentiate new products, or imitate existing products in order to maximize the equity value of the firm. The specific tasks required to achieve this objective are: (1) to estimate a spatial model of demand in a single product category, where individual products occupy a specific location in attribute space, (2) to estimate the supply-side or price-cost margins consistent with the demand structure estimated in (1) and an assumed form of the game played among product manufacturers, (3) to calculate the welfare effects implied by the introduction of new products located at varying distances from existing products, where welfare effects include measures of producer surplus, (4) to compare the results from tasks (1) to (3) to alternative estimates derived under the assumption that firms do not maximize single-period profit, but long-run firm value according to a dynamic Capital Asset Pricing Model (CAPM) and (5) to explore the effect of alternative product introduction strategies (ie., imitative or differentiating) on firm value.

The remainder of this article is organized as follows. In section two we provide a discussion of background literature that is relevant to our stated objectives. Our model is presented in section 3. Section 4 contains a discussion of our data and estimation routine. We discuss results in section 5 and provide concluding remarks in section 6.

Background

The literature on innovation in food markets is relatively deep in positive studies concerning the determinants and valuation of product-development activity (Conner, 1981; Hausman, 1994; Roder, Herrmann and Conner, 1999; Jekanowski and Binkley,

2000; Dube, 2004), but there are relatively few studies that consider the *normative* aspect of product development, or questions of whether and how firms should innovate. From this perspective, the question of whether to imitate or differentiate becomes most critical

Studies that address the positive implications of new product introduction can be divided into two camps; 1) those that use economic theory based models of demand and supply interactions to assess the impacts of product innovation on consumer and/or producer welfare, and 2) those that assess the statistical relationship between new product announcements and a firm's stock market valuation. To the best of our knowledge we have only been able to identify two papers that use the first approach to address new product activity in food categories.[2] The first is a study by Hausman (1994), who, motivated by the hypothesis that the CPI for food is biased by lack of consideration for new products, evaluated changes to consumer welfare and price index calculations due to the introduction of the ready-to-eat cereal, Honey-nut Cheerios. He found that consumer benefits from the new product introduction were quite significant. However, his research did not explore the effects of product introduction on the supply side of the market, e.g. firm profitability or market valuation. In 2004, Kim estimated the changes to consumer and producer welfare due to the introduction of three processed cheese products. Although he found evidence of benefits to consumers and producers, Kim's analysis included only 10 products, accounting for just 7% of processed cheese sales.

The alternative approach to positive valuation of new products is based on the recognition that a firm's decision to market new products may be more influenced by the

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[2] Other industries which have benefited from research on the effects of new product introduction are tomography scanners (Trajtenberg 1989), automobiles (Petrin 2002), bath tissue (Hausman 2002), and personal computers (Bayus, Erickson, and Jacobson 2003).

interests of company shareholders than by economic measures of welfare. In fact, some research suggests that the financial incentives for executives to pursue market value maximization as opposed to profit maximization is quite high (Wang, Stiegert, and Dhar 2006). This approach to new product valuation is founded on the literature regarding market returns to innovation. For example, Pakes (1985) shows that there is a dynamic relationship between a firm's innovative activity via patents and R&D and its stock market rate of return. More closely related to the objectives of our proposed research, Chaney, Devinney, and Winer (1991) use Compustat data as well as information on new product announcements from the Wall Street Journal to analyze the impact of new product announcements on the market value of firms. Their analysis consists of 1,685 announcements made by 631 firms across numerous industries including computers, chemicals and pharmaceuticals, photographic equipment, electrical equipment and appliances, and food. A similar study by Chen, Ho, Ik, and Lee (2002) focuses on the relationship between the strength and form of existing competition and the incremental market valuation returns to new product announcements. Like the study by Chaney, Devinney, and Winer (1991), Chen, Ho, Ik, and Lee (2002) take an inter-industry approach to investigating their topic. Chen, Ho, and Ik (2005) expand the literature on new product financial effects by evaluating the market value impacts on rivals of the innovative firm. They find that on average, new product announcements have a significantly negative effect on the stock prices of rival firms. A study that is similar but distinctly different from those above is a paper by Ofek and Srinivasan (2002). This article evaluates the market valuation of an improvement in a particular product attribute.

This type of "new" product introduction is quite common in food product categories (e.g. "reduced sugar" or "low fat").

The need for empirically based normative studies is further substantiated by the rich theoretical literature on product variety. Economic theory on this topic include papers by Lancaster (1975), Spence (1976a), Spence (1976b), Dixit and Stiglitz (1977), Brander and Eaton (1984), Wolinsky (1984), and Klemperer (1992). All of these articles address the question of the degree of optimal product differentiation (based on utility and profit maximization) in a market and how it is affected by numerous theoretical constructs regarding consumer and producer behavior. Lancaster (1990) provides an excellent summary of this literature and shows that the predictions of optimal differentiation vary substantially depending on assumptions regarding issues such as consumer information and production economies of scale.

There are, however, a few studies in the empirical marketing literature that make important contributions in a normative sense in that they take market structure and other real-world considerations into account in deriving optimal product development strategies. The beginnings of this literature are focused on the task of locating products in an attribute space that is actually perceptually meaningful to consumers and "actionable" for producers (Shocker and Srinivasan 1974; Shocker and Srinivasan 1979; Hauser and Simmie 1981). Most of the subsequent literature is focused on development of improved solution algorithms (Gavish, Horsky, and Srikanth 1983; Dobson and Kalish 1988). A shortcoming in this literature, which is finally addressed by Choi, Desarbo, and Harker (1990), is the use of game-theoretic models to assess the effects of competitive interactions on optimal product location. Further researchers build on this work with

game-theoretic models that address issues such as consumer uncertainty (Horsky and Nelson 1992) and the role or retailers as "gate-keepers" of the new product introduction process (Luo, Kannan, and Ratchfor 2007).

From a normative perspective, however, the usual objective of single-period profit maximization will not likely lead to optimal firm strategies. Indeed, many argue that the private-equity boom currently underway is largely due to firms managing for short-term results rather than long-term value maximization. Once private, managers are free to invest for the long-run instead of from quarter-to-quarter. If publicly-traded competitors do not follow similar strategies, they will be at a strategic disadvantage and will be forced to adjust, or will be acquired as well. As mentioned above, numerous positive studies have recognized this phenomenon in addressing the valuation of new product introductions. However, the normative research on new product introduction is yet to address this important issue. Our research will fill these gaps by providing product location recommendations based on a more complete analysis of firm objectives and market player interactions.

Our review of the literature draws attention to the need for more managerially useful information regarding new product development. To provide more useful information to new product developers in the food industry, a model that generates information on the impacts of new product introductions and how these impacts are related to the product's actual level of differentiation is needed. Empirical models based on these considerations will be able to generate managerially-significant insights into the new product development process by evaluating the welfare implications of actual product location decisions. In addition, a useful model needs to account for the

possibility that firm objectives may be better represented by considerations of market value as opposed to consumer and producer surplus measures. The evaluation of market valuation effects will provide an objective measure of the value of a new product that does not explicitly rely on changes in consumer welfare. Thus, it will be possible to infer from such measures the likely value of any slotting fees associated with a new product given the isomorphic relationship between slotting fees and real option values demonstrated by Richards and Patterson (2004).

Empirical Model of New Product Valuation

The empirical analysis of our proposed research will be divided into four stages. The first stage involves specification and estimation of a demand choice model. Next, demand parameter estimates will be carried over to a supply-side model of manufacturer profit maximization. This stage of the analysis will be used to estimate marginal costs as well as counterfactual estimates of pre-entry pricing behavior, thus accommodating the estimation of the effects of new product introductions on producer welfare. For the third stage, in place of the profit maximization model, a supply-side model of market value maximization (MVM) will be constructed and used to determine the effects of new product introduction on manufacturers' stock market returns. Finally, to address the choice of imitation versus differentiation we investigate the impact of the direction of innovation with respect to a particular product attribute on the market valuation of the firm. Each of the above steps will be discussed in-turn below.

Stage I: Demand Model

As with many other applications in marketing and industrial organization, new product valuation is inherently dependent on the estimation of substitution patterns between similar products within a category. Thus, whether or not the conclusions of such applications are of any value crucially depends on the quality of the underlying demand specification (Nevo 2000b).

The objectives of this study place a heavy burden on our selection of a demand specification. As noted in the introduction, often the most active categories in terms of new product activity are those that already possess a high level of differentiation. Thus, the most pressing need is a demand model that is parsimonious enough in parameter space to handle a large number of products.

To address these needs we incorporate the Distance Metric (DM) approach of Pinkse, Slade, and Brett (2002) and Pinkse, and Slade (2004) into a representative consumer demand system. This approach is appropriate in that it allows us to consider a large number of products and is easy to estimate. Furthermore, the DM approach exemplifies the important role of attribute proximity in determining the competitive relationships between differentiated products. Similar to other popular attribute-based models (e.g. random-parameters-logit), the DM approach reflects the intuition that products possessing similar characteristics compete on prices much more than those that are notably dissimilar. An additional advantage of applying the DM approach to a representative consumer framework is that estimation can be carried out using standard

econometric routines, unlike advanced discrete choice models that rely on simulation routines.

We allow for the possibility of multiple unit purchases in our UPC-level model, by applying the DM approach to the Linear Approximate Almost Ideal Demand System (LA/AIDS) of Deaton and Muellbauer (1980). Formally, let $i \in (1,...,N)$ be the index of brands, $t \in (1,...,T)$ the time index, $p_t = (p_{1t},...,p_{Nt})$ the vector of retail prices, $q_t = (q_{1t},...,q_{Nt})$ the vector of brand quantities demanded, and $X_t = \sum_i p_{it} q_{it}$ total expenditure in time t. Utilizing this information, we obtain the following share equations[3]:

(1) $$w_{it} = \alpha_i + \sum_{j=1}^{N} \gamma_{ij} \ln(p_{jt}) + \beta_i \ln(X_t / P_t^*),$$

where $w_{it} = \dfrac{p_{jt} q_{jt}}{X_t}$ is the expenditure share for product i in time t, $\ln P_t^*$ is a log linear analogue of the Laspeyeres price index which is similar to Stone's price index (Moschini 1995), and α_i, γ_{ij}, and β_i are parameters.

Given that our empirical application includes 31 products, estimation of the system of equations represented by (1) could be problematic from a degrees of freedom standpoint. To reduce the dimensionality of estimation, we introduce product attributes into the LA/AIDS model in a way that reduces the overall parameter dimensions of our model. To do this, each cross-price coefficients (γ_{ij}) is modeled as a function of

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[3] When brand-level analysis is conducted using a discrete choice framework, a common practice is to introduce and "outside" option to the model. However, this "outside" option falls out of the mix in the derivation of LA/AIDS share equations as a result of the standard assumption of a weakly separable utility function.

different distance measures between products i and j.[4] Specifically, defining γ_{ij} in (6) as $g(d_{ij}; \lambda_k)$ gives:

(2)
$$w_{it} = \alpha_i + \gamma_{ii} \ln(p_{it}) + \sum_{j \neq i}^{N} g_{ij}(d_{ij}; \lambda) \ln(p_{jt}) + \beta_i \ln(X_t / P_t^*),$$

where $g_{ij}(\cdot)$ is some function of d_{ij}, a vector of distance metrics, and λ is a vector of parameters corresponding to each distance metric.

The function $g(\cdot)$ is chosen by the researcher. Pinkse, Slade, and Brett (2002) advocate the use of semi-parametric techniques such as series expansion methods in selecting the specification of this function. However, we find in this and other studies (e.g. Pofahl 2008) that results are insensitive to a wide array of choices. Thus, for simplicity, we choose to specify $g(\cdot)$ as a linear function of several discrete and continuous attributes that are potentially important in defining the competitive environment in which CSDs operate.

After the model parameters are estimated, the uncompensated elasticities are calculated just as with the original LA/AIDS model, but with the function of distance metrics used in place of the cross-price coefficients (Green and Alston 1990). This substitution creates the following formula:

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[4] Our application of the DM approach begins with cross-price parameters because they are the primary source that contributes to dimensionality problems. However, Pinkse and Slade (2004) show that other model parameters can be replaced with functions of attribute levels or distance metrics. There are two reasons we do not take this additional step. First, by replacing parameters with functions involving attributes we are imposing additional structure on the model. Adding such structure to a flexible functional form does not increase flexibility but could possibly diminish it. Thus, we do not wish to impose more structure than is necessary to reduce the model dimensions to an estimable level. Second, as alluded to by Pinkse and Slade (2004), replacing other parameters with attribute functions can result in collinearity.

(3)
$$\varepsilon_{ij} = -\delta_{ij} + \frac{g(d;\lambda) - \beta_i w_j}{w_i},$$

where δ_{ij} is Kronecker's delta which equals 1 when $i=j$ and zero otherwise.

Supply Model – Profit Maximization

Given the estimation of our demand-side model, the modeling of supply-side behavior begins by first recovering marginal costs. To do this, we assume that there are M manufacturers, each producing a unique set $K_1, K_2, ..., K_M$ of brands. We also assume that each firm is a profit maximizing entity and competes with the other manufacturers over prices (Bertrand competition). The profit function for the mth firm is:

(4)
$$\Pi^m = \sum_{k \in K_m} (p_k - c_k) q_k(P)$$

where c_k is the marginal cost of producing manufacturer m's kth brand. Re-expressing the first order conditions in elasticity and share form obtains the following:

(5)
$$\frac{\partial \Pi^m}{\partial p_k} = w_k + \left(\frac{p_k - c_k}{p_k}\right) \varepsilon_{kk} w_k + \sum_{l \in K_m} \left(\frac{p_l - c_l}{p_l}\right) \varepsilon_{lk} w_l = 0 \qquad \forall k \in K_m$$

where, given that X is total expenditure, the demand elasticities and expenditure shares are defined by,

(6)
$$\varepsilon_{lk} = \left(\frac{\partial q_l}{\partial p_k}\right) \frac{p_k}{q_l} \quad \text{and} \quad w_k = \frac{p_k q_k}{X}$$

respectively. Using estimated demand elasticities, and mean prices and expenditure shares, we can then solve the first-order-conditions for the unknown marginal costs.

Once marginal costs are obtained, we use counterfactual simulation to estimate

the optimal prices that should exist in absence of any new products introduced by the

firms. This is done by removing the new products from a firm's set of first order

conditions and resolving for the objective maximizing prices. As with other studies using

similar supply side models, we assume that marginal costs remain fixed and their post-

introduction levels. However, in addition to changes to prices, we also allow for the

removal of new products from our supply model to affect the revenue shares of each

firms' remaining products. Given the simulated changes to prices and revenue shares, we

estimate changes to producer surplus using the following expression:

(7) $$\left[\Pi^m(p_0, mc : \alpha, \gamma, \lambda, \beta) - \Pi^m(p_1, mc : \alpha, \gamma, \lambda, \beta) \right],$$

where p_0 is a vector of counterfactual pre-introduction equilibrium prices, p_1 is a vector

of post-introduction equilibrium prices, mc are marginal cost estimates, and $\alpha, \gamma, \lambda, \beta$ are

estimated demand parameters.

Supply Model – Market Value Maximization

Many recent studies consider the implications for marketing strategy of maximizing firm

value in the context of a theoretically-consistent asset pricing model instead of single-

period profit (Chaney, Devinney and Winer, 1991; Sundaram, John and John, 1996;

Wang, Stiegert and Dhar, 2006). Based on this research, the implications for new

product development are expected to be significant. On an intuitive level, if managers

take financial-market considerations into account in making strategic marketing decisions,

the implications for the perceived riskiness of an investment in the firm become

important. In equilibrium asset valuation models, risk involves not just the stand-alone

risk of a particular venture or strategy, but how the decision affects the correlation of returns to investing in one company relative to the market as a whole. Because investors can diversify any idiosyncratic risk, it is this correlation, or systematic risk that is priced by the market.

In order to compare the new product response under an assumption of equity value maximization to simple profit maximization, the objective function in (8) is modified to include financial considerations following Wang, Stiegert and Dhar (2006). According to the CAPM, in financial-market equilibrium, the equity of company i must be priced such that expected returns to holding its stock are consistent with the risk it adds to an otherwise well-diversified portfolio. This "systematic risk," is measured by the firm's "equity beta," and is estimated as the slope of a regression line relating expected returns to holding the stock of company i ($\hat{r}_i$) to the return expected from holding the market portfolio ($\hat{r}_m$):

$$(8) \qquad \beta_i = \sigma_{im}/\sigma_m^2,$$

where σ_{im} is the covariance between r_i and r_m, and σ_m^2 is the variance of returns to the market portfolio.[5] The expected return to holding stock i, therefore, is given by:

$$(9) \qquad \hat{r}_i = r + \beta_i[\hat{r}_m - r],$$

where r is the risk-free rate of return, generally considered the yield on a U.S. government 10-year treasury bond. This expression can be simplified by defining $\theta = [\hat{r}_m - r]/\sigma_m^2$ as the market price of risk so that equation (14) is rewritten as:

$$(10) \qquad \hat{r}_i = r + \theta\sigma_{im}.$$

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[5] Expected values of all random variables are indicated with a caret.

Define the present value of all future cash flows as: $V_i = \hat{\pi}_i/(1+\hat{r}_i)$ where $\hat{\pi}_i$ is the expected value of all future cash flows. Because $\hat{\pi}_i/V_i = (1+r_i)$ we can write the covariance between firm and market rates of return in terms of the covariance between firm cash flows and the market rate of return as: $\sigma_{im} = \hat{\sigma}_{im}/V_i$ and solve for the value of firm equity as:

$$(11) \qquad V_i = (1+r)^{-1}(\hat{\pi}_i - \hat{\sigma}_{im}\theta).$$

Incorporating the expression for profit (cash flow) defined above, the value maximization problem can be written as:

$$(12) \qquad V_i = \underset{p_k,x_k}{MAX} \sum_{k \in K_f} (1+r)^{-1}\left((p_k - mc_k)w_k Q - F_f - \hat{\sigma}_{im}\theta\right),$$

for each firm, f, in the industry.

Using the expression for firm value in (12), therefore, we are able to estimate changes in a firm's market valuation due to new product introductions via:

$$(13) \qquad \left[V_i(p_0, mc, r_0, \hat{\sigma}_{im0}, \theta_0) - V_i(p_1, mc, r_1, \hat{\sigma}_{im1}, \theta_1)\right],$$

where subscripts 0 and 1 indicate values corresponding to pre- and post-introduction periods.

Recognizing that the share expression in (12), w_k, is a function of product attribute proximity measures, we can infer the direction of change to market valuation based on a firm's decision to imitate or differentiate along some attribute dimension. This is done by differentiating (13) with respect to the attribute proximity measure of interest.

Data

For our empirical exercise we utilize national-level sales data obtained from Information

Resources, Inc. Our data consists of unit sales and revenues for the top 500 CSDs from

September, 2002 until July, 2007. Periods are measured in 4-week increments, thus

giving us 65 observations for each product. Products are defined at the brand-level, thus

we make no distinction between different product sizes. We aggregate each product to

this level and then generate weighted average prices per ounce where unit sales are used

as weights. We select products that account for at least half a percent of revenue share

for the five year period. This selection rule results in 31 products that account for over

90% of total category revenues. Only one new product was successful enough to make

our list of top products – Diet Coke with Lime. This product was introduced in the 20th

period of our data, thus giving us 45 post-introduction observations to estimate our

demand system.

In addition to the sales data described above, we also collect nutritional data on

each product from the internet, including carbohydrates (g), sodium (mg), and caffeine

content. Due to inconsistencies in firm reporting, we are not able to define caffeine

content on a continuous basis but instead create indicator variables for products that

contain caffeine as opposed to those that do not. In a similar fashion, we generate brand,

flavor, and diet indicators for each product.

Finally, to implement our market value maximization model we collect stock-

price financial data from Yahoo Finance. Based on the new product introduction

considered, we collect stock-price data for Coke that corresponds to the pre- and post-

introduction periods. In addition, we use the S&P 500 index to represent r_m in our market

value model. For our 'risk-free' rate of return we use data for 10 year U.S. treasury

bonds. A summary of CSD products and all data measures can be found in table 1 below.

[Table 1 in here]

Before estimating our demand system we use our product attribute data to

construct numerous measures of product proximity. We create four discrete metrics for

brand, flavor, caffeine, and diet status of each product. For example, the discrete metric

for brand is equal to 1 if two products are the same brand and 0 otherwise. The caffeine,

diet measures are defined the same way. Our flavor metric has three values, 1 if two

products have the same first and secondary flavors, ½ if the products have the same

primary flavor, but differ in their secondary flavor, and 0 otherwise. Continuous

attributes are constructed from the carbohydrate and sodium contents of each product.

For example, we use the Euclidian-based metric $d^{So} = 1 \Big/ \left(1 + 2\sqrt{(So_i - So_j)^2} \right)$ to measure

how close together two products are in sodium space. A similar metric is defined for

carbohydrate content. However, due to a high correlation between carbohydrate content

and our diet indicator we only include one of the two metrics in our distance metric

function. Thus, the function we use to replace all cross-price parameters in our original

demand system is given as:

(14) $$g(\cdot) = \lambda_0 + \lambda_1 d^B + \lambda_2 d^F + \lambda_3 d^C + \lambda_4 d^D + \lambda_5 d^{So},$$

where d are distance metrics defined in brand, flavor, caffeine, diet, and sodium space,

respectively, and the $\lambda's$ are parameters to be estimated.

After substituting (14) into (2) we drop the last of our 31 share equations and estimate the remaining 30 equations using a seemingly unrelated regression routine. Estimation is carried out using the 45 post-introduction observations.

Results

Due to the large number of demand parameters we only report on model fit, and the distance metric parameters. We also provide a brief summary of the elasticity estimates. Overall, model was fit was good. As can be seen in table 2, the average R-squared value for all 30 share equations was .76. All attribute proximity measures result in statistically significant coefficients except for the discrete diet measure. As a side note, we also ran the model once using a continuous proximity measure for carbohydrate content and found this measure to be a statistically insignificant contributor to demand price responses. Proximity in brand and flavor appear to be the most important attributes in determining price responses. The negative sign for the brand metric indicates that price competition is lower between same-brand products as opposed to different brand products. This implies that complementary, as opposed to substitution relationships dominate in intra-brand competition, i.e. consumers purchase regular and diet Coke together as opposed to in place of one another. Such behavior could be explained by households that are brand loyal yet are characterized by varying intra-brand preferences (i.e. diet versus regular) within the same household.

[Table 2 in here]

Own-price elasticity estimates are all statistically significant at the 5% level and are reasonably close to those obtained in other studies. Estimates range from a -3.5 to -.72 with an average of -1.87. In comparison, Dube (2004) obtains CSD elasticities ranging from -2.11 to -3.61. However, his study is conducted at the universal- product-code level, meaning that his model treats different sized products as potential competitors, thus increasing the number of substitution alternatives. In general, the cross-price elasticities characterize substitution across brands but complementary relationships within brands.

Counterfactual price estimates, changes, and resulting effects on producer surplus measures can be found in table 3. Using the counterfactual price estimates that were obtained by removing Diet Coke with Lime from the first order pricing equations we can see that the introduction of this new product causes optimal equilibrium prices to decline for 6 of the 10 pre-existing products. For example, in equilibrium the price of Diet Coke Classic drops 2.4% from .0223 to .0217 due the introduction of Diet Coke with Lime. Relatively large negative price changes can be seen with other specialty coke products such as Caffeine Free Coke, Vanilla Coke, and Cherry Coke. On the other hand, equilibrium prices for Coke's citrus line of products are estimated to increase due to the introduction of Diet Coke with Lime. For example, Diet Sprite and Fresca prices increase in equilibrium by 8.3 and 2.2 percent, respectively. Overall, the portfolio price effect of the new product introduction is an average price decrease of almost two percent.

Due to the price changes an subsequent market share adjustments, Coke's profit estimate declines roughly 16% as a result if the introduction of Diet Coke with Lime. Similarly, we estimate that the firm's market value declines by roughly the same amount. Admittedly, these results are somewhat counter-intuitive and cannot be fully accepted without further analysis.[6]

As an initial investigation into the question of whether or not firms should imitate or differentiate in new product introductions, we estimate the marginal effect of flavor proximity on Coke's market valuation. This estimate can be found in table 3. It can be seen that Coke's entire market valuation would virtually disappear if there was no difference between the flavor of Coke's products and other competitors in the market.

Conclusions

In this paper we use data from the CSD industry to evaluate the producer welfare implications of associated with the introduction of Diet Coke with Lime. In addition to changes in firm profits, we estimate the effects on Coke's market valuation using counterfactual price estimates and publicly available stock price return data. Using our model of market value maximization we are able to estimate the effects of a firm's decision to imitate or differentiate from existing products along some product attribute dimension. We find that imitation of existing flavors is detrimental to improving the market value of a firm in this industry. We also find that the introduction of Diet Coke

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[6] In addition to the estimated changes to Coke's portfolio of products, it is likely that the new product introduction under consideration caused prices of other firm's products to change as well. These additional prices changes could have positive implications for movement of Coke's portfolio, thus off-setting the reduced margins generated by the price reductions. We are currently modeling this possibility and will update our conclusions when these results are obtained.

with Lime has a negative impact on both profit and market valuation due to an overall negative impact on Coke's product-line pricing.

As noted earlier, our results are limited along several lines. First, our counterfactual price estimates are based on the assumption of Bertrand price competition with no consideration of possible channel interactions between retailers and manufacturers. It is quite possible that some form of strategic interaction exists between market players that could change our equilibrium price estimates. Furthermore, in this draft we do not account for the likely price effects and subsequent share adjustments of products outside the Coke family that would likely result from the introduction of Diet Coke with Lime.

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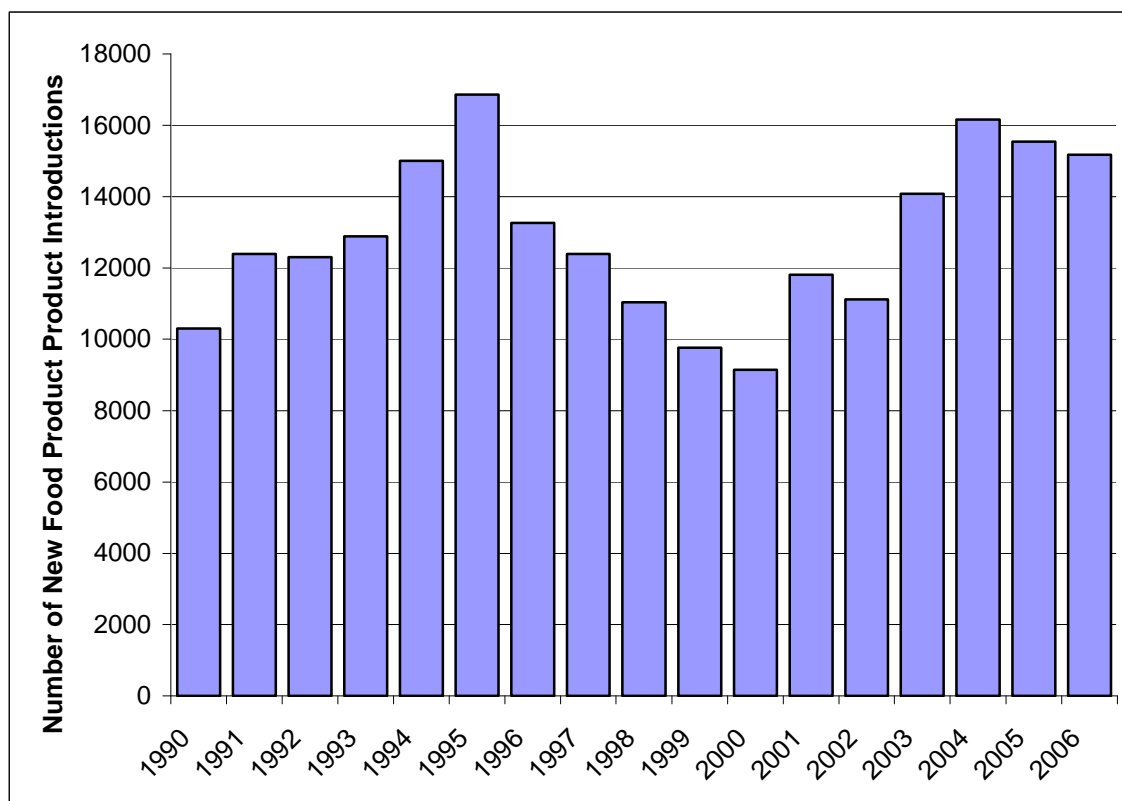
FIGURE 1 New Product Introductions in the U.S. Food Industry

Source: 1990-2000 data – Harris (2002); 2001-2006 data – Mintel, GNPD

Table 1. Product list and attribute values

Manufacturer/Products	Share %	Carbs (g)	Sodium (mg)	Caffeine	1st Flavor	2nd Flavor	Price $/oz.
Cadbury Schweppes	**14.8**						
Dr Pepper	5.0	27	35	1	pepper	-	.022
Diet Dr Pepper	2.1	0	35	1	pepper	-	.022
7up	1.9	25	25	0	citrus	lemon	.019
Sunkist	1.3	35	30	1	citrus	orange	.020
A&W Rootbeer	1.0	31	30	0	rootbeer	-	.020
Diet 7up	1.0	0	30	0	citrus	lemon	.019
Canada Dry Ginger Ale	1.0	33	40	0	ginger	-	.022
Diet Rite	0.6	0	0	0	cola	-	.019
Diet A&W Rootbeer	0.6	0	45	0	rootbeer	-	.019
Squirt	0.5	26	35	0	citrus	grapefruit	.019
Coca-Cola, Inc	**39.5**						
Coke Classic	16.5	27	33	1	cola	-	.022
Diet Coke	9.4	0.1	28	1	cola	-	.022
Sprite	4.9	26	47	0	citrus	lemon	.022
Caffeine Free Diet Coke	3.3	0.1	28	0	cola	-	.019
Diet Sprite	1.2	0	24	0	citrus	lemon	.023
Cherry Coke	0.8	28	28	1	cola	cherry	.022
Caffeine Free Coke	0.8	27	33	0	cola	-	.018
Fresca	0.6	0.1	24	0	citrus	grapefruit	.019
Diet Coke with Lime	0.6	0.1	28	1	cola	lime	.023
Vanilla Coke	0.5	28	25	1	cola	vanilla	.023
Barqs Rootbeer	0.5	30	48	1	rootbeer	-	.019
Diet Cherry Coke	0.5	0.1	28	1	cola	cherry	.020
PepsiCo.	**32.3**						
Pepsi Cola	12.5	28	20	1	cola	-	.018
Diet Pepsi Cola	6.5	0	25	1	cola	-	.021
Mountain Dew	5.9	31	40	1	citrus	dew	.023
Caffeine Free Diet Pepsi	2.0	0	25	0	cola	-	.018
Diet Mountain Dew	1.8	0	35	1	citrus	dew	.021
Sierra Mist	1.3	26	25	0	citrus	lemon	.021
Caffeine Free Pepsi	1.1	28	20	0	cola	-	.017
Wild Cherry Pepsi	0.6	28	20	1	cola	cherry	.020
Mug Rootbeer	0.5	29	40	0	rootbeer	-	.019

Table 2. Summary of demand system estimation

		Distance metric	Coefficient	p-value
Adusted R-squared*	0.76	Brand	-0.0036	[.000]
Durbin Watson*	1.95	Flavor	0.0026	[.000]
		Caffeine	-0.0022	[.000]
		Diet	0.0000	[.608]
		Sodium	0.0015	[.000]

* Values are averages over all 30 estimated share equations

Table 3. Price and producer welfare changes due to the introduction of Diet Coke with Lime

	Counter-Factual	Post-Introduction	Change
Prices for:	$/oz.	$/oz.	%
Coke Classic	.0216	.0216	-0.27
Diet Coke	.0223	.0217	-2.59
Sprite	.0222	.0222	0.24
Caffeine Free Diet Coke	.0192	.0193	0.62
Diet Sprite	.0209	.0227	8.30
Cherry Coke	.0227	.0215	-5.06
Caffeine Free Coke	.0221	.0185	-16.18
Fresca	.0187	.0191	2.23
Vanilla Coke	.0239	.0227	-5.24
Barqs Rootbeer	.0196	.0194	-1.17
Financial measures	%	%	
Avg. 4-week return - Coke	2.35	0.45	
Avg. 4-week return S&P 500	1.82	0.90	
Avg. 4-week return 10YTB*	0.33	0.31	
Beta	0.36	0.96	
Producer Surplus	$	$	$
Profit	$2,581,360,000	$2,158,410,000	-16.38%
Market Value	$2,385,610,000	$2,003,580,000	-16.01%
Imitation versus Differentiation		Estimate	p-value
	Flavor	-3,793,700,000	[.000]

* 10YTB = 10 year U.S. treasury bond